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FLIGHT DEMONSTRATION OF THE AltAir AIR DEPLOYED BALLISTIC MISSILE TARGET

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Abstract

Theater Missile Defense (TMD) testing identified the need for a new type of TMD target system. The system must provide intercept geometries which are difficult to achieve with current ground launch systems. The government undertook the development of the Alternate Air launched short range target (AltAir) to demonstrate the feasibility of meeting these requirements with an air-launched system. The objective of this effort was to develop a target system which could be integrated at conventional range facilities, loaded into an unmodified cargo aircraft, flown to a remote location for extraction from the aircraft and launched. The AltAir program developed the following target system elements: the AltAir target vehicle with its GPS aided guidance system; a Palletized Airborne Support Equipment (PASE) module, and associated ground support equipment. The range processing and operating procedures required to integrate, transport and launch the AltAir vehicle were developed by the Navy and Air Force units supporting the program. Five airborne tests of the AltAir target system elements were performed culminating in the AltAir Demonstration Flight. The AltAir Demonstration Flight occurred on 30 January 1997 on the Sea Test Range at the Naval Air Warfare Center - Weapons Division, off the coast of California.

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1.0 Introduction

The AltAir flight test program was undertaken to answer questions of feasibility regarding the "Air Drop" concept for ballistic target presentation.

The Air Drop concept air-delivers SRBM-like targets to Theater Missile Defense (TMD) interceptor development tests and satisfies test requirements which were considered unattainable. Air Drop involves extracting the target missile from a cargo aircraft by the same method used to drop heavy equipment via parachute. The missile's solid propellant motor ignites after descending on its parachutes and then flies a threat representative course. Figures 1-1 and 1-2 show the AltAir system integration and the loading of the vehicle into the C-130. Figure 1-4 shows the AltAir flight vehicle and its related systems as they are configured within the C-130 host aircraft prior to AltAir vehicle extraction and launch.

In order to properly emulate TMD threats, target missiles must be representatively large (full scale) and have performance margins which provide threat representative apogee and range combination. BMDO has a requirement to provide a cost efficient and operationally flexible target and delivery platform(s) to the Services in all operating locations. TMD testing requirements include multiple simultaneous engagements (M on N) at multiple launch azimuths. Either launch sites must be developed for existing targets at new locations, or a new launch system must be developed which is launched in an alternative method. The AltAir Flight Demonstration Program is the first step towards providing targets which meet TMD requirements through the application of air launched ballistic missile technology.

AltAir provides target simulation throughout its flight. Since the Air Drop concept allows target launch from locations without ground or sea based launch sites, the AltAir can perform missions which provide a threat representative reentry angle and velocity without using a second stage burn to shape the trajectory (see Figure 1-3). The system provides both range and azimuth as control variables when designing the mission experiment. The entire flight of the target can therefore be utilized to evaluate TMD systems. The ignition, boost and exo-atmospheric coast periods of a typical AltAir mission all are threat representative when viewed from ground or space borne sensors.

The Air Drop flexibility will allow the target to be flown from off-range to on-range. Flying the target on-range to the interceptor has the advantage of using the on-range radar for maximum data collection during the reentry phase. With the use of airborne sensors, such as the Navy RASA (Remote Area Support Aircraft) or USAF ARIA (Advanced Range Instrumentation Aircraft), the necessary range assets to provide a test could be taken to interceptors in the field (broad ocean or similar locations).

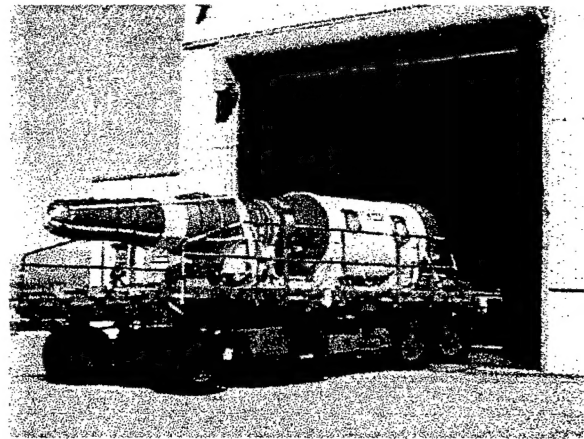


Figure 1-1 AltAir Integration on Sled and Loader

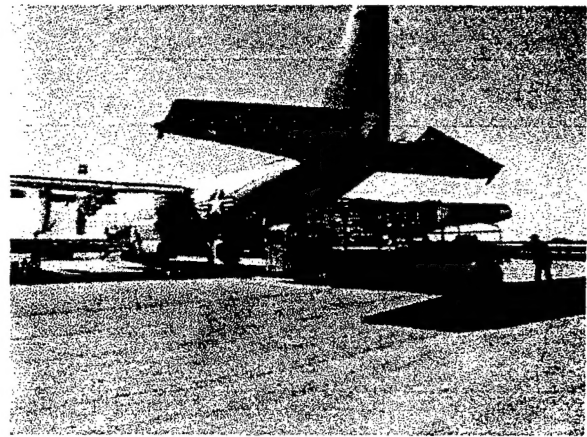


Figure 1-2 AltAir Being Loaded into C-130

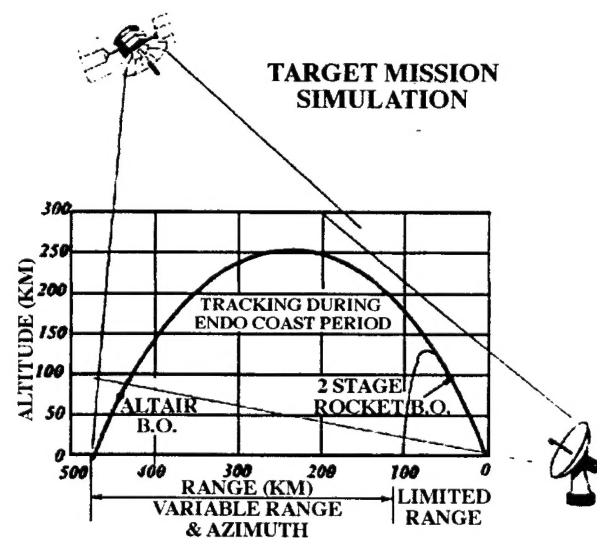


Figure 1-3 Typical Target Vehicle Mission

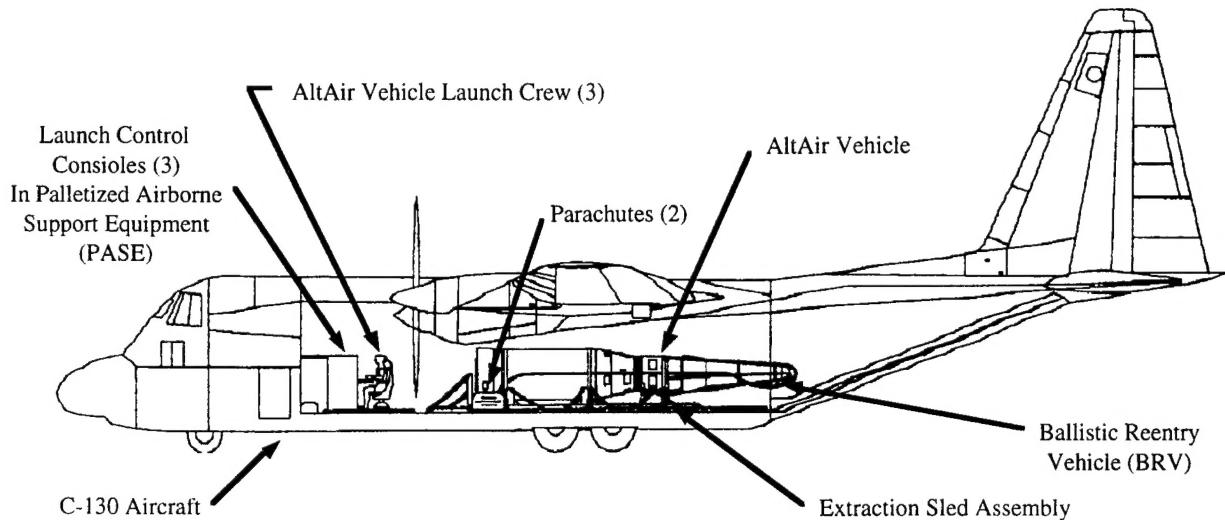


Figure 1-4 AltAir System in Host C-130 Aircraft

Target launches from a mobile platform may well be less objectionable to environmental concerns than building new land based launch sites. Use of the AltAir TMD target delivery system should eliminate most concerns regarding the need for constructing or testing in environmentally sensitive areas.

The AltAir Vehicle's performance envelope is plotted in Figure 1-5. The nominal mission for the AltAir Demonstration Flight Test is shown in Figure 1-6. It includes a burnout flight path angle of 66.66° with the apogee occurring at T+261 seconds at an altitude of 118 nm (218 km). The nominal impact point is 169 nm (313 km) downrange at about T+477 seconds.

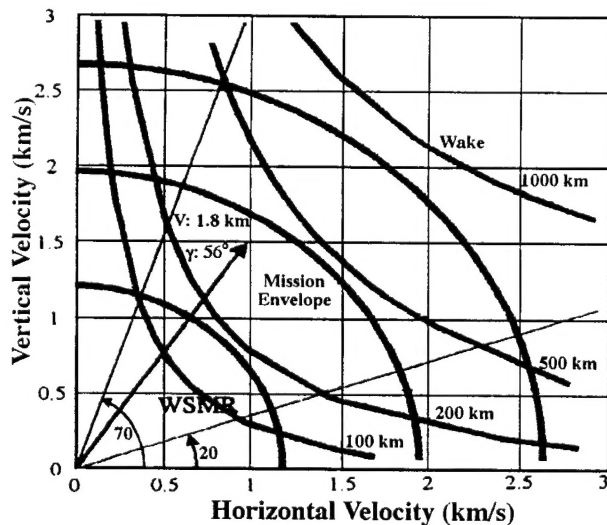


Figure 1-5 AltAir Performance Envelope

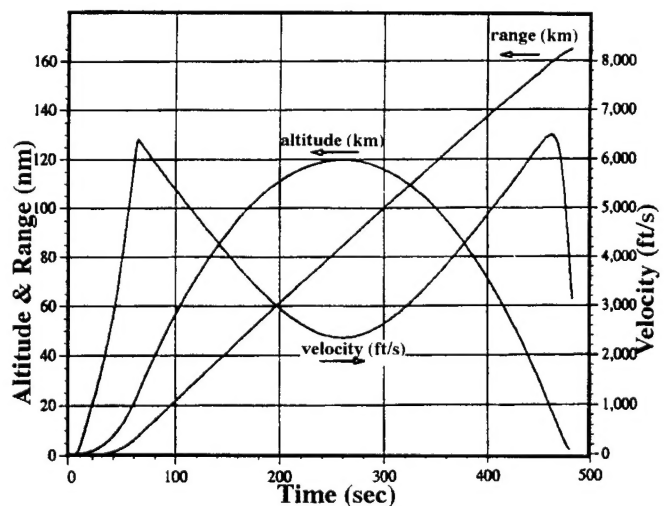


Figure 1-6 AltAir Nominal Performance

2.0 AltAir Demonstration Flight

The AltAir Flight Demonstration was highly successful achieving ~ 90% of the program objectives. AltAir was launched at 13:55, Pacific Standard Time (PST) on Thursday, 30 January 1997. The purpose of the test was to demonstrate the Air Drop concept with emphasis on:

- 1) GPS initialization of the inertial navigation system and
- 2) Correction of position and velocity errors incurred during deployment via the AltAir retargeting algorithm.

A summary of system performance against the flight test plan program objectives is presented in Appendix A.

Mission Summary - The AltAir vehicle was extracted from a Navy supplied C-130 at an altitude of 15,000 feet Mean Sea Level (MSL) over the Sea Test Range at NAWCWPNS, Point Mugu, California (see test sequence - Figure 2-1). It descended on dual parachutes to 5,000' MSL. Following the parachute release command, the SR19 was ignited on command from the guidance computer. The control system captured the descending vehicle and placed it into the flight programmed position.

The vehicle flew along the programmed 316° azimuth resolving 180° of roll induced while on the parachutes. An error in the control software caused the TVC nozzle to limit cycle which exhausted the system's hydraulic fluid at T+22.5 seconds. Once TVC was lost, the vehicle began to tumble. The MSFO subsequently initiated vehicle destruct. The AltAir extraction and launch sequence is shown in Appendix B, Figures B-1 through B-6.

2.1 AltAir I Vehicle Performance

Launch and Flight Events - The AltAir launch and flight critical events occurred at their predicted times with no timeline anomalies. All time-line events prior to flight termination at T+33 seconds were verified through telemetry.

Up-Link Igniter Enable - The AltAir system is designed to utilize a discrete up-link signal to activate the SR19 booster igniter (arm). The signal was sent by the MFSO as planned and the vehicle igniter armed at T-45.1 seconds.

GPS/INS Initialization - The AltAir guidance and control system and PASE provided GPS/INS initialization (ALTNAV). The system acquired GPS satellites on the C-130 and initialized the system. The selected satellite set consisted of SV's 03, 10, 14, 18, and 19 with 02 and 27 intermittently selected.

The ALTNAV system integrated the GPS data with the Inertial Measurement Unit (IMU) data using a Kalman filter to determine the initial state data, and to calibrate the bias errors in the IMU. The Kalman filter outputs a covariance matrix which provides a

statistical approximation of the "fit" of the measurement data with the state data solution. Initialization errors were on the order of 0.25 degrees in heading and 0.07 degrees for the pitch and roll axis.

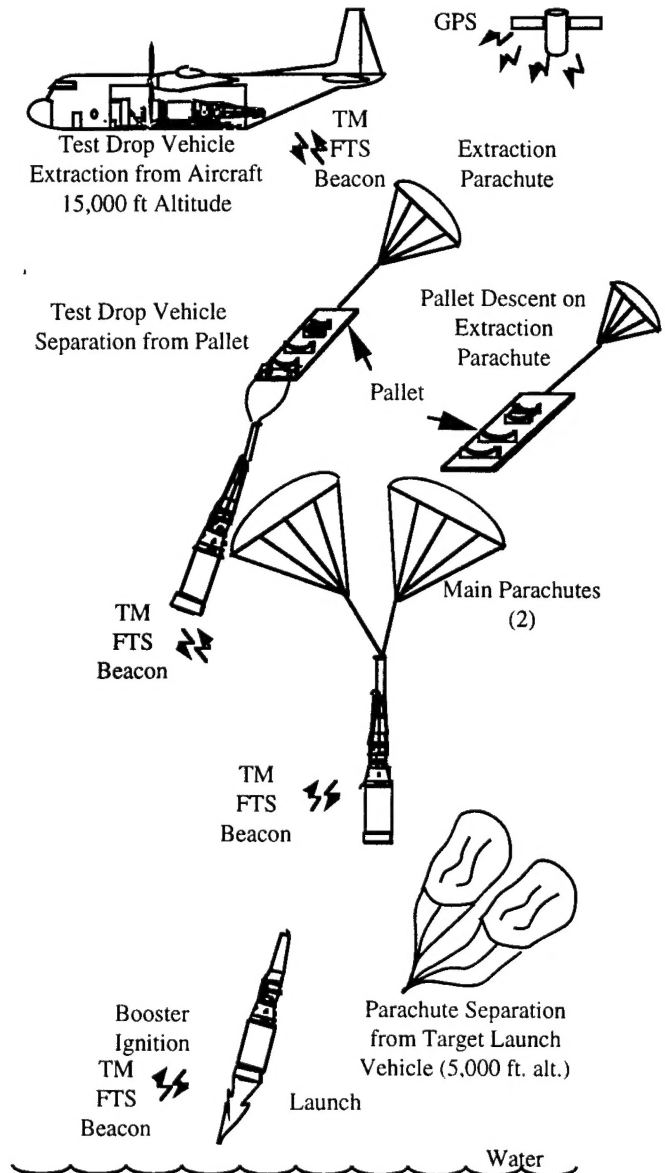


Figure 2-1 AltAir Demonstration Test - Extraction and Launch Sequence

Guidance - Initial deviations from the preprogrammed inertial state vector in the vehicle placement and velocity were compensated with the retargeting algorithm. The nominal launch azimuth for the AltAir flight was -43.6 degrees from North. The corrected launch azimuth for vehicle position at T=0 was -43.969 degrees. Flight TM confirmed the AltAir retargeted correctly.

Tracking Data - The range radar used for the demonstration flight is accurate to within 35 feet in the horizontal and 45 feet in the vertical position based on the range to target, elevation and azimuth angular uncertainty of the radar tracker. Figure 2-2 shows a ground trace of GPS, guidance computer and range radar data.

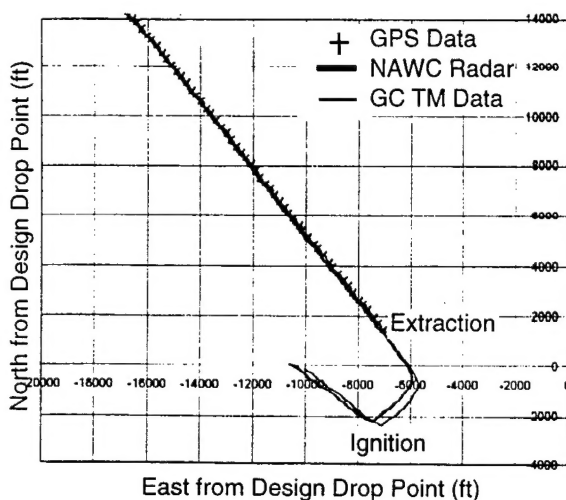


Figure 2-2 TM vs Radar Position

Boost Pitch/ Yaw Control - The boost control system consists of the flight control computer and IMU, the Vehicle Interface Unit (VIU), the P92 amplifier, and the booster nozzle assembly. At ignition the control system captured the vehicle in the vertical orientation in approximately 2.5 seconds and then began the programmed pitch-over.

Boost Roll Control - Roll control was achieved through the SR19 hot gas Roll Control System (RCS) which consists of 2 opposing nozzles on the base of the motor. The RCS was initiated by the AltAir guidance computer T+3 seconds after ignition. The RCS captured the commanded roll angle and maintained that angle within 1 degree for the remainder of the controlled flight.

2.2 AltAir Extraction System Performance

During the AltAir Demonstration mission, extraction of the sled/vehicle from the C-130 occurred as demonstrated on previous drops. The extraction parachute was successfully deployed by the crew of the C-130 on a verbal mark from the Operations Conductor (OC) at T-0 (T-86 seconds vehicle). The sled/vehicle exited the aircraft pulling all umbilical connectors.

Following separation from the sled, the 2 main descent parachutes were deployed as the vehicle began

to free fall away from the sled. Both parachutes inflated evenly in the reefed condition. Disreef occurred as predicted at 6 seconds after parachute deployment.

A dynamic simulation developed by SVC was used to predict vehicle altitude and velocity at vehicle ignition. A plot of this simulation along with the actual flight TM data is provided in Figure 2-3.

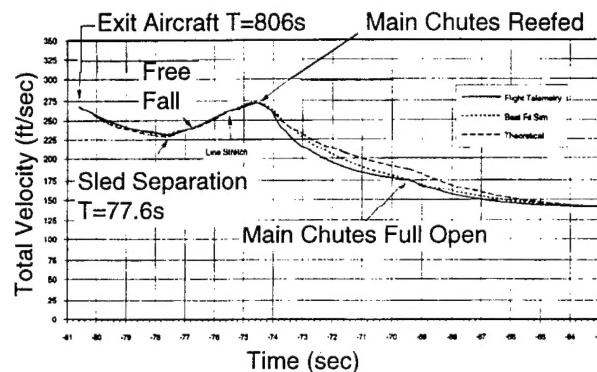


Figure 2-3 Parachute Performance

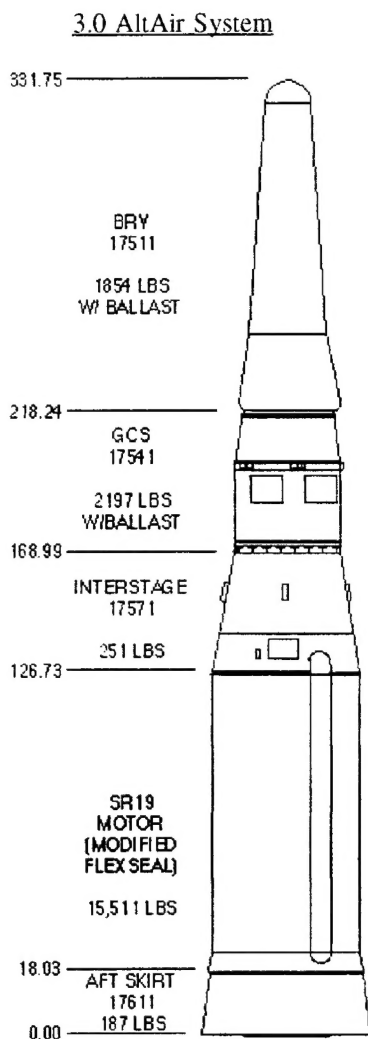


Figure 3-1 AltAir Vehicle

3.1 Vehicle Description - (Figure 3-1)

The AltAir target vehicle is 332 inches (8.43 m) long with a base diameter of 57.725 inches (1.47 m). It is a single stage vehicle powered by a modified Minuteman II second stage rocket motor; the SR19-AJ-1. The total weight at ignition is 20,000 lb. as shown in Table 3-1. The AltAir vehicle consists of the five sections described below along with their associated major subsystems.

Table 3-1 AltAir Mass Properties

Description	PN	Wt (lb)	Xcg (in)
BRV	17511	1,854	277.8
GCS & Ballast	17541	2,197	204.0
Interstage	17571	251	146.6
SR19 (burn out)	SR19AJ1	1,706	44.7
Aft Skirt	17611	187	8.4
Burnout		6,195	174.0

Burnout	6,195	174.0
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Expended Propellant & Inerts	13,805	75.3
Lift Off	20,000	105.9

Ballistic Reentry Vehicle (BRV) - (Figure 3-2) -

The BRV utilized in the AltAir flight demonstration was a HERA test unit, manufactured by the Aerotherm Corporation and provided as GFE.

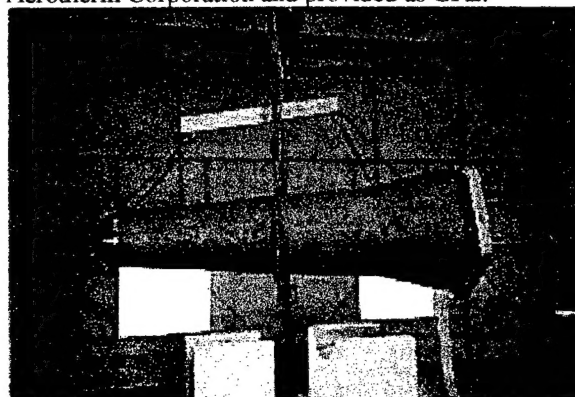


Figure 3-2 AltAir BRV

Guidance and Control Section (GCS) - The GCS section contains the following major subsystems:

- Guidance, Navigation and Control System (including GPS)
- Telemetry System (S-Band and C-Band)
- Parachute Retention/ Release System
- Environmental Data Acquisition System

The inertial guidance system is a fiber optic gyro (Litton LN200 - Figure 3-3) and 68030 based guidance computer (OR RCP30 - Figure 3-4) running SVC's ARIES-ALV software adapted for the SR19. The inertial guidance system is initialized aboard the C-130 and controls inertially during the flight. The initialization system uses the AltAir's GPS receiver, an aircraft mounted GPS antenna and a specialized computer hardware/ software package mounted in the PASE.

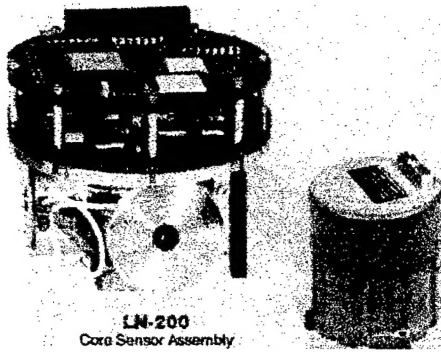


Figure 3-3 ALTAIR IMU (LN200)

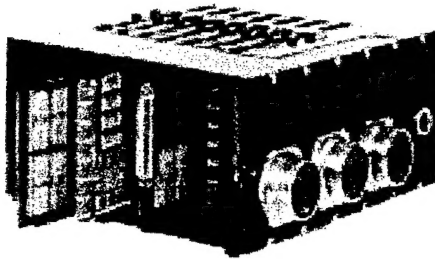


Figure 3-4 ALTAIR GC (OR RCPU30)

The telemetry system uses an S-band down-link to transmit vehicle housekeeping and guidance computer data. The inertial guidance data and the raw GPS data in the S-band TM stream can be used by range safety to supplement radar data for missile flight safety command destruct decisions. AltAir included a C-band transponder beacon to aid in tracking the vehicle in flight. The demonstration flight carried a set of vibration and thermal sensors. The data from these sensors was included in the S-band TM stream.

The parachutes used on the AltAir demonstration mission were provided as GFE. The vehicle releases itself from the parachute riser lines at a predetermined time after C-130 extraction through the actuation of multiple explosive release devices.

Minuteman II 2/3 Interstage - The AltAir demonstration flight included a Minuteman II 2/3 interstage. It was provided as GFE and modified by Space Vector. The modifications included the installation of a horizontal restraint for personnel safety during transportation and extraction from the C-130. The interstage houses the AltAir Flight Termination System (FTS) electronics and initiation subsystems. This FTS system is a dual redundant electro-explosive system which responds to up-linked commands from the Missile Flight Safety Officer (MFSO). The FTS system was designed and qualified in compliance with the Range Commanders Council Standard 319-92 for missile flight safety and the related documents for other ranges (†).

Minuteman II SR19-AJ-1 Motor - The booster is a Minuteman II ICBM second stage rocket motor. The AltAir demonstration flight's unit was provided as GFE from the USAF's Space and Missile Center (USAF-SMC). The SR19 configuration used on AltAir is modified from the ICBM baseline to include a flexseal nozzle and 'blow-down' hydraulic Thrust Vector Control (TVC) system (see Figure 3-5). The SR19 was flown with the flexible heat shield installed as shown in figure 3-6. For detailed data about the SR19 (as flown), refer to the SR19 handbook (‡).

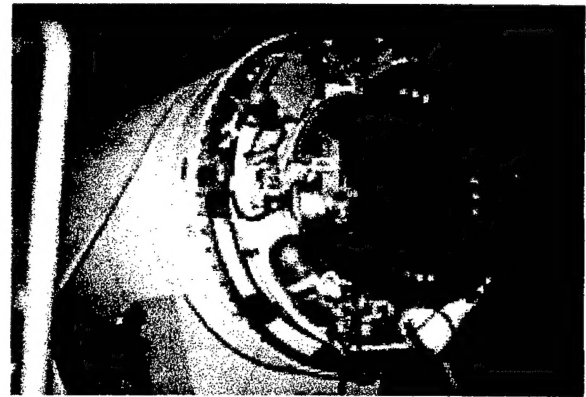


Figure 3-5 SR19 Flex Nozzle

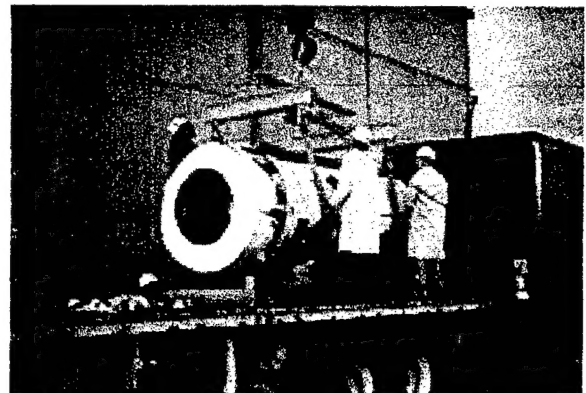


Figure 3-6 SR19 Handling

Aft Skirt - The Aft Skirt structure is made from a GFE Minuteman II 1/2 interstage. SVC made modifications to the GFE structure to strengthen it and to control heating during SR19 burn. These modifications included the addition of an internal ablative and the addition of a support ring.

3.2 Extraction System Description (Figure 3-7)

The extraction system consists of the sled assembly and the parachute system. The sled assembly consists of two substructures: 1) the standard C-130 Type V metric pallet (aluminum decking which interfaces to the C-130's cargo restraint system) and 2) the program specific AltAir vehicle cradle (steel weldment which supports and restrains the vehicle). The AltAir vehicle build-up and its integration with the payload are performed on the sled assembly and then the sled assembly is used to mechanically interface the AltAir with the aircraft.

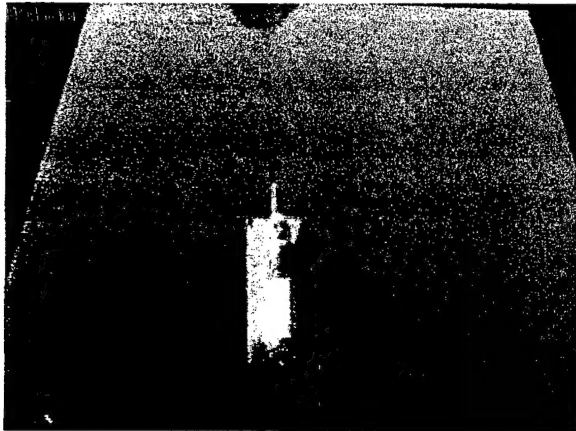


Figure 3-7 AltAir Extracted from C-130
(As Seen From C-130 Cargo Bay)

The sled assembly is designed to restrain the vehicle in three-axis and to withstand up to a 10 G aircraft impact load (horizontal restraint). The sled assembly includes the mounting for the parachutes and the electro-explosive vertical restraint/ release system. (see Figures 3- 8 & 3- 9).



Figure 3- 8 AltAir on Sled Assy & Roller Dock

A ring-slot parachute is used to extract the sled/vehicle from of the C-130 at 15,000 feet MSL. Three seconds later the vehicle is separated from the sled and pulls out

the two main parachutes as it falls away. The main flat ribbon parachutes (two each) are reefed to reduce the initial opening force. The vehicle is ignited two seconds after main parachute release at an altitude of around 5,000 feet MSL.

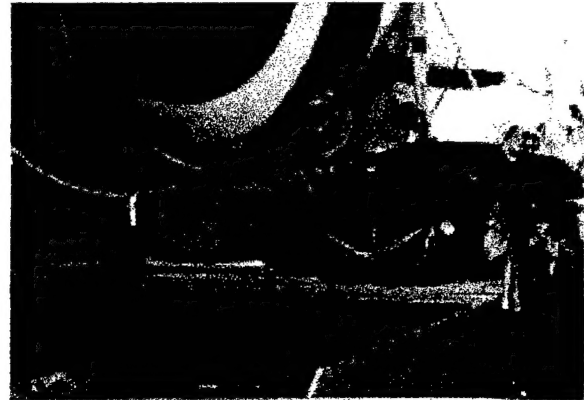


Figure 3- 9 Vert. Restraint Parachute & Cradle

4.0 AltAir Test Program

Test planning support was provided by EAFB and NAWCWPNS (*). The milestone airborne tests included:

- CTV Tests - Mass simulator extraction tests which were performed concurrent with the AltAir program.
- P Test - Initial test of the AltAir extraction, release and parachute systems
- B Test - Final test of the AltAir extraction, release and parachute systems
- CC1 Test - Initial captive airborne test of the AltAir GPS initialization and flight procedure validation
- CC2 Test - Final captive airborne test of the AltAir GPS initialization and flight procedure validation

Flight Demo - AltAir Flight Demonstration Launch

The AltAir Demonstration Program was successfully completed in thirteen months thanks to the joint cooperation and support of all the organizations involved.

All drop tests were initiated with extraction of the sled assembly from C-130 transport at 15,000 feet. The extraction parachute was attached to the sled/pallet. In each of the drop tests, the test drop vehicle was separated from the sled/pallet following extraction from the aircraft, which initiated deployment of the vehicle main

parachutes. The sled/pallet descended on the extraction parachute while the vehicle descended on the main parachutes. During vehicle descent the C-130 aircraft exited the launch area. Release of the main parachutes from the vehicle occurred at approximately 5,000 feet for the P and B tests.

4.2 AltAir P & B Tests - (Figure 4-1)

Prior to the AltAir Demonstration Flight Test, SVC completed two tests (P & B) designed to validate the AltAir extraction and parachute systems. These tests were performed with flight similar vehicle hardware and an identical sled assembly. Both the P & B tests were performed at the Navy NAWC facility at China Lake, California. The tests were performed over land and hardware was recovered for post test evaluation.

The bending loads on the AltAir vehicle during the sled separation event and main parachute deployment during the initial P test were significantly higher than predicted. During the P test, one of the GCS aft structural joints failed. A joint correction redesign/ modification was implemented for all subsequent hardware.

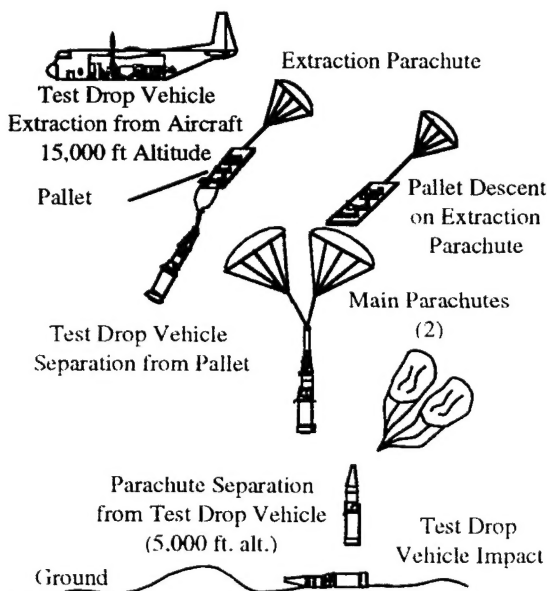


Figure 4-1 P and B Drop Tests

4.3 AltAir Captive Carry Tests - (Figure 4-2)

The AltAir airborne and ground based subsystems underwent dry-run testing and in-flight check-out in the weeks preceding the AltAir Flight Test. These tests were designated Captive Carry 1 (CC1) and Captive Carry 2 (CC2), because the AltAir vehicle was flown to the launch site in its flight configuration, but the vehicle was not released from the C-130.

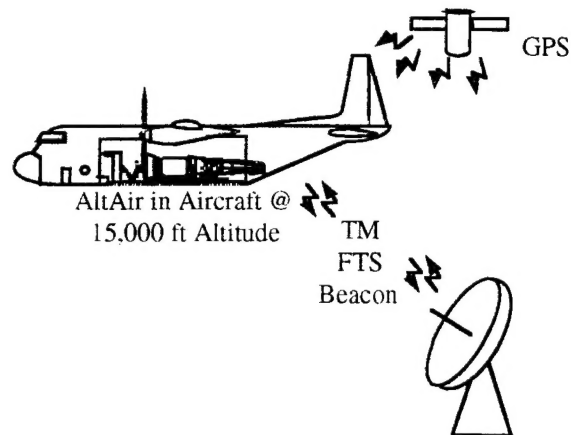


Figure 4-2 Captive Carry Tests

The objective of these tests was to validate the in-flight GPS initialization of the AltAir Inertial Navigation System (INS), dry-run air-borne procedures, and serve as a practice exercise for the AltAir launch. All of the range elements which supported the AltAir flight demonstration were involved in the Captive Carry tests including: range operations center, missile flight safety, telemetry recording, range radar, C-130, and the AltAir vehicle launch team and support personnel. All of the objectives of the Captive Carry Tests were achieved.

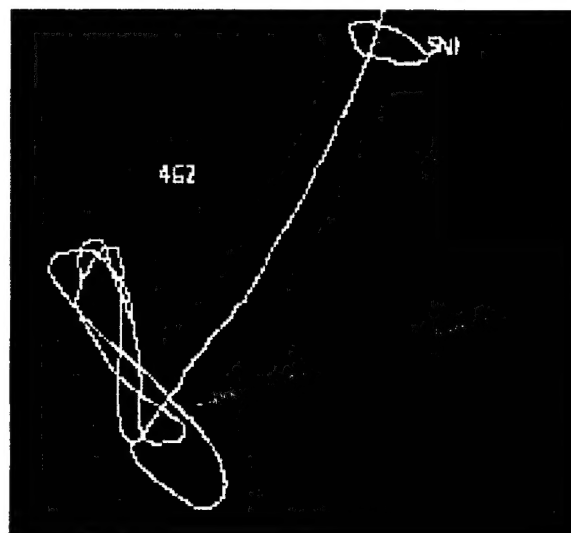


Figure 4-3 C-130 Ground Trace: CC2

An aircraft ground trace of the second Captive Carry is shown as Figure 4-3. It shows the distinctive "bow-tie" aircraft maneuvers which were flown to collect GPS initialization data.

5.0 AltAir Support Equipment

5.1 Airborne Support Equipment Description

The vehicle interfaces to the Palletized Airborne Support Equipment (PASE) shown in Figure 5-1 through the GCS umbilical cable and the FTS umbilical cable. The PASE consists of two computer terminals and a control panel. The terminals are mounted in a rack structure bolted to an existing 8' Type V platform. In addition, the aircraft intercom interfaces, UHF Receiver / Transmitter, and console operators are all mounted on the PASE. An external GPS antenna is mounted on the C-130. It is connected to the vehicle through a separate dedicated umbilical cable.

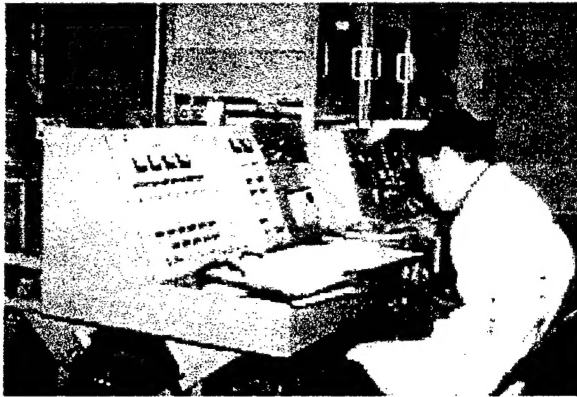


Figure 5-1 AltAir PASE (in OAB)

5.2 Ground Support Equipment

The AltAir vehicle integration and test requires a variety of GSE items developed by SVC to support the AltAir program. Items provided by SVC included: test consoles, simulators, test sets, etc. Figure 5-2 shows some of these GSE items (break-out box, squib simulators, SR19 booster simulator and other test specific items) in use during the AltAir integration testing performed in the NAWC Ordnance Assembly Building (OAB).

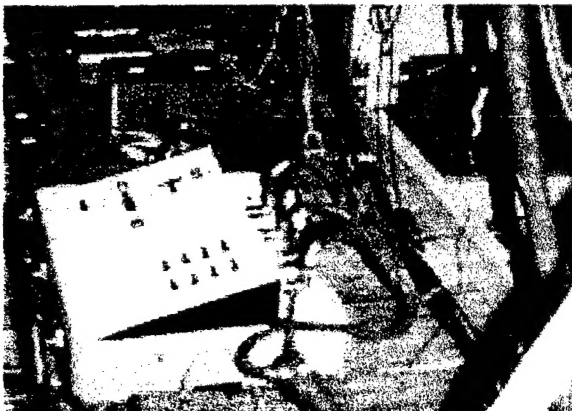


Figure 5-2 AltAir GSE (in OAB)

6.0 Range Operations Support

NAWCWPNS provided support to the AltAir Flight Demonstration Program in the buildup of the AltAir target vehicle. In section 1.0, Figure 1-1 shows the roll-out of the target vehicle from the Missile Assembly Building and Figure 1-2 shows the loading of the test vehicle into the NAWCWPNS C-130 prior to its flight on the Sea Range. The airborne operation was controlled on the Sea Range from the control room shown in Figure 6-1. A NAWCWPNS NP-3D aircraft with the CAST GLANCE system was tracking the C-130 aircraft and the ALTAIR drop which was taking place approximately 100 miles away from the control room. The NP-3D aircraft telemetered this information to the control room in real time, where it was displayed on the wide screen display.



Figure 6-1 Sea Range Control Room

For the maiden flight of the AltAir test vehicle, organic land-based test assets were used to monitor and control the operation of the AltAir target. It is envisioned that in future operations, the NAWCWPNS NP-3D RASA aircraft could control the AltAir target vehicle with its own organic assets.

AltAir Testing Site(s) - The test ranges at the Naval Air Warfare Center-Weapons Division (NAWCWPNS) provided support to the AltAir Flight Demonstrations Program. In order to select the test range most suitable for performing the AltAir test program, the National Air Intelligence Center (NAIC) conducted a range selection study (§). Nine different test ranges were evaluated against 16 different selection criteria, including range cost, range support facilities, range instrumentation and C-130 aircraft availability. NAWCWPNS was selected as the AltAir test location. NAWCWPNS owns both the land range at China Lake and the sea range at Point Mugu, and due to the close proximity of the two ranges test management and logistics lines were greatly shortened.

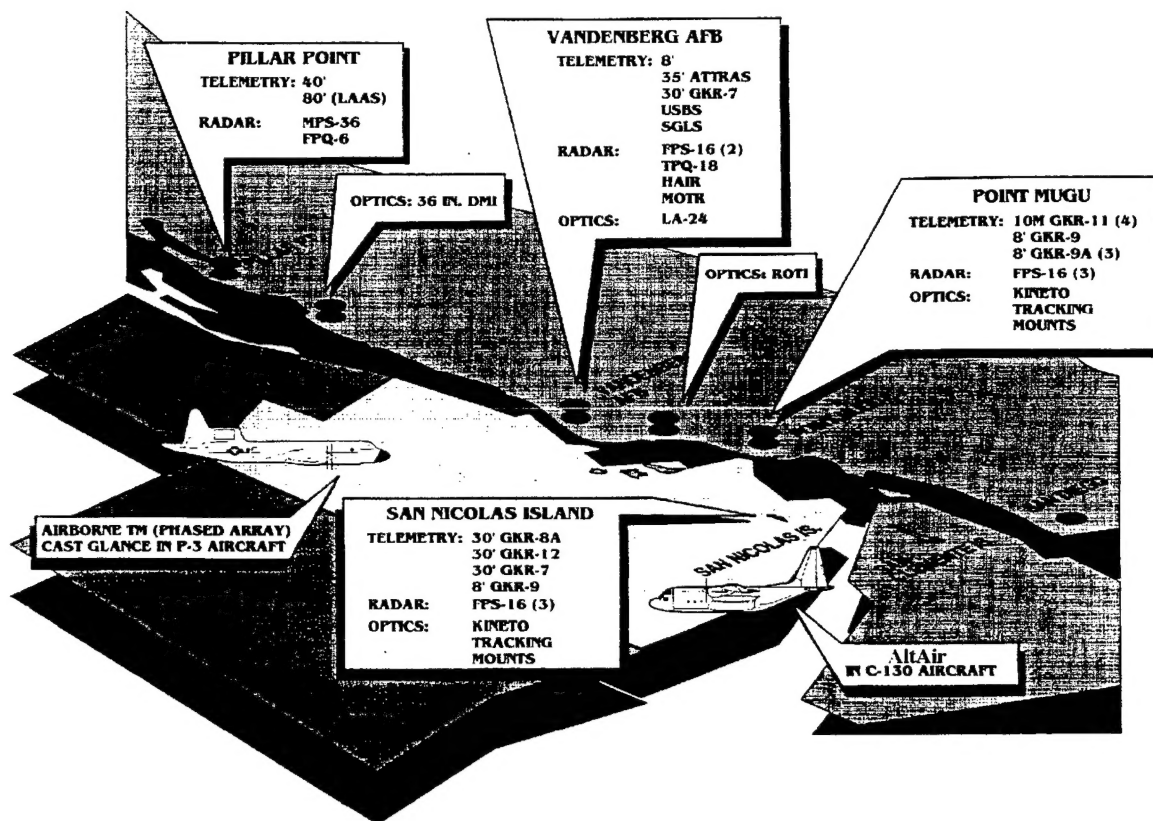


Figure 6-2 NAWCWPNS Sea Range and Vandenberg AFB Instrumentation Complex

The two ranges also offered sophisticated tracking, telemetry and flight termination systems. The combination of test assets at the NAWCWPNS Sea Range and the Vandenberg AFB complex provided full coverage for the AltAir demonstration flight (see Figure 6-2).

7.0 Conclusions and Points Of Contact

7.1 Conclusions

The AltAir Flight Demonstration Flight Program was part of an on-going airborne target development effort. The Government is planning further development flight(s) and to support the transition from system development to the fielding of larger numbers of airborne targets for TMD testing. Test scenarios planned for the future may include vastly more stressing test situations. These scenarios involve targets emulating a variety of threat combinations such as: side looking, behind, forward, high gamma, low gamma, multiple and simultaneous threats. The AltAir Flight Demonstration Program is the first step towards providing targets which meet TMD requirements through the application of air launched ballistic missile technology.

7.2 Organizational Points of Contact - The AltAir Program was an effort of the United States Air Force's National Air Intelligence Center (USAF - NAIC), at Wright Patterson Air Force Base (WPAFB), Ohio under the direction of the Ballistic Missile Defense Organization (BMDO). It was performed under the Air Force's HAVE GOLD contract with XonTech Incorporated. The AltAir contractor under HAVE GOLD is Space Vector Corporation. The AltAir Demonstration Flight was performed at the Navy Air Warfare Center at Point Mugu, CA. The parachute system was provided by USAF 450th TS/LGHSP at Edwards Air Force Base. The Points of Contact for these organizations are as follows:

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FAX: 805-277-5009

8.0 References

- * Meeker, B.: Test Plan - AltAir Demonstration: Naval Air Weapons Center Document: 1997, also see NAWC China Lake Document 96A102 by Theis, C.
- † Flight Termination Systems Committee, Range Safety Group, Range Commanders Council: Flight Termination Commonalty Standard: White Sands Missile Range Document 319-92, also see Eastern Range and Western Range Safety Document ER/WR127-1 & NASA Document GFSC-WFF RSM-93
- ‡ Flight Termination Systems Committee, Range Safety Group, Range Commanders Council: Flight Termination Commonalty Standard: White Sands Missile Range Document 319-92, also see Eastern Range and Western Range Safety Document ER/WR127-1 & NASA Document GFSC-WFF RSM-93
- § AltAir Ballistic Target Short Range Flight Test Demo -Range Selection Study of 20 Mar 1996

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Appendix A
AltAir Flight Test Objectives

Item	Objective	Priority	Success Criteria	Success
1	Demonstrate Launch and Performance of the AltAir Target Vehicle from an Unmodified C-130 Aircraft	Primary	Obtain Trajectory, TM, and Visual Data to Assess Overall System Performance	Successful
		Primary	Demonstrate the following discrete events: Safe Extraction from C-130 Sled/Vehicle Separation Main Parachute Deployment Main Parachute Release Booster Ignition	Successful Successful Successful Not Successful Successful
2	Acquisition of GPS State Vector Data & Transfer to Vehicle G&C System	Primary	Transfer of GPS Data to Initialize Vehicle Guidance System Prior to Extraction from C-130	Successful
3	Confirm Sizing of Parachutes	Primary	Obtain State Data to Validate Predicted Ignition Altitude and Velocity Using 28' Diameter Extraction Chute and Two 43.5' Diameter Main Chutes	Successful
4	Verify Structural Integrity of Flight Vehicle	Primary	Vehicle Maintains Structural Integrity throughout Mission	Successful
5	Verify Dynamic Simulation and Load Calculations	Primary	Obtain State Data to Validate Dynamic Simulations and Parachute Loading Conditions	Successful
6	Validate Field Procedure, Preflight Processing, & Launch Countdown	Primary	Completion of the Field Procedures and the Launch Operational Countdown	Successful
7	Demonstrate Remote Arming of the Igniter by the MFSO	Primary	Uplink Tone 4 from Ground and Verify Igniter Arm	Successful
		Primary	Obtain Positive C-Band Track and Flight Termination Communication during All Mission Phases	Successful
8	Demonstrate Guidance and Control of the AltAir Target Vehicle during Flight	Primary	Capture and Begin Upward Velocity Resolve Roll Induced during Parachute Descent Begin Down Range Pitch Program Control vehicle through-out flight & achieve impact CEP	Successful Successful Successful Not Successful
9	Demonstrate Performance of the Airborne Support Equipment (PASE)	Primary	Provide Power Switching, Monitoring, and Ordnance Status of the Vehicle from the PASE	Successful
		Primary	Use External Mounted GPS and S-Band Antennas to Acquire Satellites and Transfer Vehicle TM Data while inside the C-130	Successful
		Primary	Confirm Pull Away of Umbilical Cables During Extraction	Successful
10	Demonstrate Safe Loading, Transport, and Extraction of a Large Missile Booster on a Standard 24' Type V Platform from an Unmodified C-130	Primary	Transport Complete Missile from OAB on 25K Loader and Safely Load into C-130	Successful
		Primary	Transport Missile on Sled Assembly Inside Unmodified C-130 to Predetermined Drop Point	Successful
		Primary	Safely Extract Sled/Vehicle from Aircraft and Confirm Separation of Vehicle from Sled	Successful
11	Demonstrate Flight Safety Parameters	Primary	Confirm the Aircraft can attain a Safe Separation Distance following Vehicle Extraction	Successful
12	Verify Communication with all Test Participants during the Operation	Primary	Confirm Communication between the OC, Aircraft, PASE, and Ground Support throughout Operation	Successful
13	Reacquire GPS following Vehicle Extraction	Secondary	Reacquire GPS State Data following Extraction from Aircraft and Transmit to Ground via TM.	Not Successful
14	Obtain Environmental Data	Secondary	Collect Temperature, Vibration, and Acceleration	Successful

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Appendix B
Photographs of the AltAir Demonstration Flight Test -
AltAir Extraction, Descent and Ignition
(Images Collected by Navy NAWCWPNS NP-3D Aircraft)



Figure B-1 AltAir Extraction



Figure B-4 Main Parachute Deployment

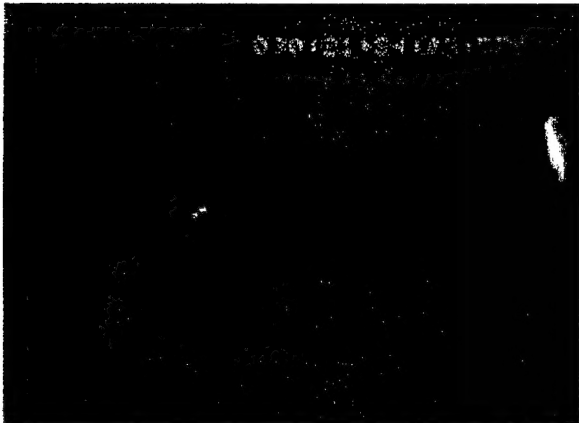


Figure B-2 AltAir On Sled



Figure B-5 AltAir On Parachutes

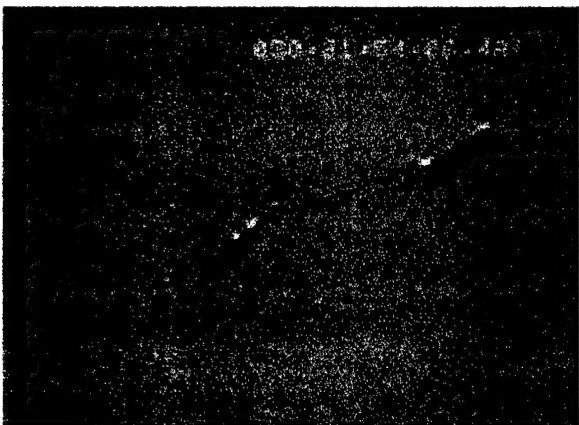


Figure B-3 AltAir Off Sled



Figure B-6 AltAir Ignition

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